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WHAT IS CLAIMED IS:

1. A method of measuring the potential differences for plasma processing with a plasma processing apparatus that processes a sample by introducing a gas into vacuum chambers and generating plasma, wherein said method of measuring potential differences for plasma processing is characterized in that

a light-emitting portion is formed on a measurement-use sample,

a current flows into said light-emitting portion according to the potential difference that has been generated across said light-emitting portion,

the intensity of the light emitted from said light-emitting portion according to the particular level of said current is measured, and

the potential difference on said measurement-use sample according to the particular light intensity is measured.

2. A method of measuring the plasma currents for plasma processing during which the plasma processing of a sample is accomplished by introducing a gas into vacuum chambers and generating plasma, wherein said method of measuring plasma currents for plasma processing is characterized in that

a light-emitting portion is formed on a measurement-use sample,

the flow of charged particles from the plasma to the surface of said measurement-use sample is measured as the intensity of the light emitted from said light-emitting portion according to the level of the current flowing thereinto, and

the amount of current flowing into said light-emitting portion according to the particular light intensity is measured.

3. An apparatus for measuring plasma potential differences and currents in a plasma processing apparatus that provides a sample with plasma processing by introducing a gas into vacuum chambers and generating plasma, wherein said potential difference and current measuring unit is characterized in that it has

a light-emitting portion formed on a measurement-use sample, allowing a current to flow into said light-emitting portion according to the potential difference that has been generated across said light-emitting portion, and measuring the intensity of the light emitted from said light-emitting portion according to the particular level of said current,

and measures the potential difference on said

measurement-use sample according to the particular light intensity.

4. An apparatus for measuring plasma potential differences and currents in a plasma processing apparatus that provides a sample with plasma processing by introducing a gas into vacuum chambers and generating plasma, wherein said potential difference and current measuring unit is characterized in that it has

a light-emitting portion formed on a measurement-use sample, and a means by which the flow of charged particles from the plasma to the surface of said measurement-use sample is measured as the intensity of the light emitted from said light-emitting portion according to the level of the current flowing thereinto,

and measures the amount of current flowing into said light-emitting portion according to the particular light intensity.

5. A potential difference and current measuring method using a potential difference and current measuring portion provided with one pair of conductor antennas, a light-emitting portion connected between said pair of conductor antennas, and an alternating-current (AC) voltage bypass element connected to said

light-emitting portion, wherein said potential difference and current measuring method is characterized in that when said pair of conductor antennas are arranged at and connected to the measuring positions on the object to be measured, light will be emitted from said light-emitting portion and the direct-current (DC) potential differences and DC currents at said measuring positions will be measured by the detection of the intensity of the emitted light.

6. A potential difference and current measuring method as set forth in Claim 1, 2 or 5 above, wherein said potential difference and current measuring method is characterized in that said potential difference and current measuring portion consists of multiple potential difference and current measuring members arranged at and connected to the spaced measuring positions on the object to be measured.

7. A potential difference and current measuring method as set forth in Claim 1, 2, 5, or 6 above, wherein said potential difference and current measuring method is characterized in that said potential difference and current measuring portion consists of multiple potential difference and current measuring members arranged at and connected to the

spaced measuring positions on the object to be measured, and in that the light-emitting portion of each potential difference and current measuring member consists of one or more light-emitting diodes or combination of one or more diodes and light-emitting elements using filaments.

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8. A potential difference and current measuring method as set forth in Claim 5 above, wherein said potential difference and current measuring method is characterized in that said light-emitting portion consists of the light-emitting diodes or combination of diodes and light-emitting elements using filament, one with positive polarity and the other with negative polarity, and in that the DC potential difference at said measuring position and the corresponding voltage polarity are judged by the detection of light emission or no light emission from the light-emitting diodes or light-emitting elements.

9. A potential difference and current measuring apparatus as set forth in Claim 3 or 4 above, wherein said potential difference and current measuring apparatus is characterized in that said potential difference and current measuring portion consists of multiple potential difference and current measuring members arranged at and connected to the spaced

measuring positions on the object to be measured.

10. A potential difference and current measuring unit as set forth in Claim 3 or 4 above, wherein said potential difference and current measuring unit is characterized in that said potential difference and current measuring portion consists of multiple potential difference and current measuring members arranged at and connected to the spaced measuring positions on the object to be measured, and in that the light-emitting portion of each potential difference and current measuring member either consists of the light-emitting diodes or combination of diodes and light-emitting elements using filament

11. A potential difference and current measuring unit as set forth in Claim 9 or 10 above, wherein said potential difference and current measuring unit is characterized in that said light-emitting diodes are different in light-emission threshold voltage and light-emitting diodes are different in emission color as well.

12. A potential difference and current measuring unit as set forth in Claim 9 or 10 above, wherein said potential difference and current measuring unit is characterized in that when the potential between two equivalent measuring position is measured, said light-

emitting portion, which consists of the light-emitting diodes or combination of diodes and light-emitting elements using filaments, has its forward and reverse polarized diodes taken as one set.

13. A potential difference and current measuring unit as set forth in Claim 9 or 10 above, wherein said potential difference and current measuring unit is characterized in that said light-emitting portion includes a thin gate oxide film in a semiconductor device.

14. A potential difference and current measuring unit as set forth in Claim 9 or 10 above, wherein said potential difference and current measuring unit is characterized in that said AC voltage bypass element is a capacitor.

15. A potential difference and current measuring method as set forth in Claim 7 above, wherein said potential difference and current measuring method is characterized in that said potential difference and current measuring portion has resistor elements connected to said light-emitting portion either in series or in parallel.

16. A potential difference and current measuring method as set forth in Claim 7 above, wherein said potential difference and current measuring method is

characterized in that said potential difference and current measuring portion has optical fibers arranged adjacently to said light-emitting portion and in that light emission from said light-emitting portion is detected through said optical fibers.

17. A potential difference and current measuring method as set forth in Claim 7 above, wherein said potential difference and current measuring method is characterized in that said measurement-use sample is a semiconductor wafer and in that said measuring positions are two spaced positions on said semiconductor wafer.

18. A potential difference and current measuring method as set forth in Claim 7 above, wherein said potential difference and current measuring method is characterized in that the semiconductor wafer, which is said measurement-use sample, is located inside the plasma reactor that provides surface treatment.

19. A potential difference and current measuring method as set forth in Claim 7 above, wherein said potential difference and current measuring method is characterized in that said light-emitting portion emits light of the wavelength that enables transmission through the semiconductor substrate used as said measurement-use sample.

20. A potential difference and current measuring method as set forth in Claim 7 above, wherein said potential difference and current measuring method is characterized in that when the light emitted from said light-emitting portion is monitored, measurements are performed from the reverse side of the semiconductor substrate used as said measurement-use sample mentioned.

21. A potential difference and current measuring unit as set forth in Claim 9 above, wherein said potential difference and current measuring unit is characterized in that it includes a light-emitting circuit having diodes connected in parallel to said light-emitting portion.

22. A potential difference and current measuring unit as set forth in Claim 5 above, wherein said potential difference and current measuring unit is characterized in that in addition to the fact that the measuring unit uses a potential difference and current measuring portion provided with one pair of conductor antennas and a light-emitting portion connected between said pair of conductor antennas, a structure made of an easily removal insulating body is mounted on one antenna.

23. A potential difference and current measuring

unit as set forth in Claim 5 above, wherein said potential difference and current measuring unit is characterized in that said antennas are made of a light metal such as impurity-doped silicon, aluminum, or magnesium, or of electroconductive carbon.

24. An etching rate measuring apparatus characterized in that the conductor portions of antennas A and B are exposed in approximately plane form and in the form surrounded by an insulating body, respectively, and in that when the intensity of the light from the light-emitting portion connected between the antennas is measured, the time dependence of the light emission intensity is examined and the etching rate is measured from two factors: the time from the start of the emission to the end, and the thickness of the conductor portion of antenna B.

25. An etching rate measuring method characterized in that the conductor portions of antennas A and B are exposed in approximately plane form and in the form surrounded by an insulating body, respectively, and in that when the intensity of the light from the light-emitting portion connected between the antennas is measured, the time dependence of the light emission intensity is examined and the etching rate is measured from two factors: the time

from the start of the emission to the end, and the thickness of the conductor portion of antenna B.

26. A method of optimizing a plasma etching apparatus designed so as to generate plasma by introducing a gas into vacuum chambers, wherein said plasma etching apparatus optimization method is characterized in that said potential difference and current measuring portion is installed inside said etching apparatus and in that operating parameters on the etching apparatus are optimized from the relationship between the gas introducing position, the shapes of the reaction chamber, sample mount, and other apparatus components, and the intensity of the light emitted from the light-emitting portion of the potential difference and current measuring portion.

27. A method of optimizing the plasma etching parameters used to generate plasma by introducing a gas into vacuum chambers, wherein said plasma etching parameter optimization method is characterized in that said potential difference and current measuring portion is installed inside said etching apparatus and in that etching parameters are optimized from the relationship between parameters, such as the type of gas to be introduced, the flow rate of the gas, and the magnitude of the power to be applied, and the

intensity of the light emitted from the light-emitting portion of the potential difference and current measuring portion.

28. A sample processing method intended to process a sample by introducing a gas into vacuum chambers and generating plasma, wherein said sample processing method is characterized in that

a means of measuring potential differences is so constructed as to ensure that a light-emitting portion is formed on a measurement-use sample and measure the intensity of the light emitted therefrom according to the particular amount of current, and that the potential difference on said measurement-use sample is measured according to the measured light intensity,

in that

each time said sample within said vacuum chamber is processed the required number of times, said potential difference is measured using said measurement-use sample,

and in that

if said potential difference exceeds the required value, the processing of said samples will be interrupted.

29. A sample processing method intended to process a sample by introducing a gas into vacuum

chambers and generating plasma, wherein said sample processing method is characterized in that

a means of measuring plasma currents is so constructed as to ensure that a light-emitting portion is formed on a measurement-use sample, that the flow of charged particles from the plasma to the surface of said measurement-use sample is measured as the intensity of the light emitted from said light-emitting portion according to the level of the current flowing thereinto, and that the amount of current flowing into said light-emitting portion according to the particular light intensity is measured,

in that

each time said sample within said vacuum chamber is processed the required number of times, the plasma current is measured using said measurement-use sample,

and in that

if said plasma current exceeds the required value, the processing of said samples will be interrupted.